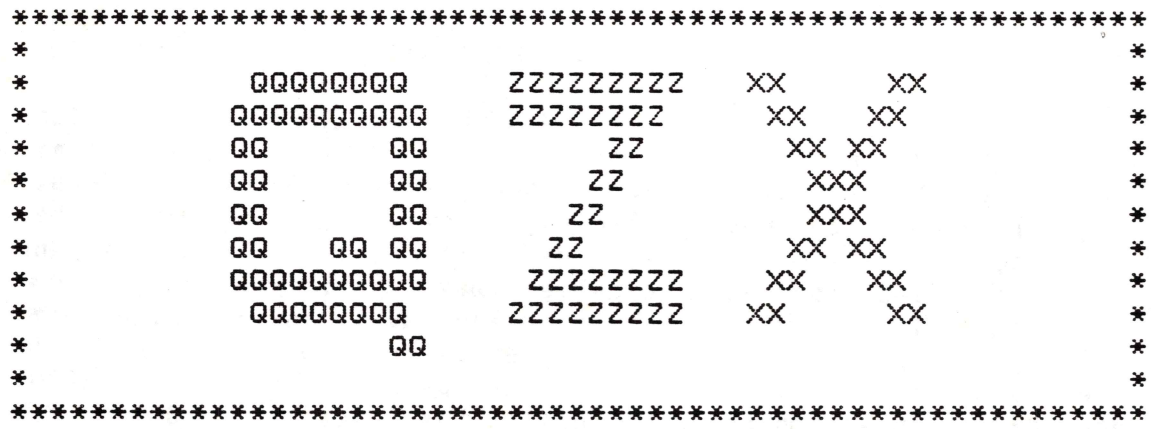

The Journal Covering Amateur Radio & Sinclair Computers
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EDITOR'S NOTES
K5XY

The feature article in this issue (by Don Lamen) is the result of a lot of original work. Don has worked hard to bring you details of the custom chip in the TS1000 series of computers. The article is quite technical but will give readers more insight in the design of computer systems, and none of the electronics involved need worry a ham.

Not all articles submitted to QZX need be as original as this one or as innovative as the articles from LU8MAD. Many readers like to try out short programs; especially if there is accompanying commentary on the programing techniques used. If you have one, send it in for our other readers to enjoy. The only requirement is that it have at least some connection with amateur radio or electronics.

CORRECTION TO CW PRACTICE

There was some difficulty with a few lines in the TS2068 CW PRACTICE PROGRAM which appeared in the 1989 AUGUST QZX. The original, sent me by WA6DLI, was in perfect condition. I expect that a printer left a thumb print on the master. In any case, the lines between 4046 and 4080 had part of the left hand side obscured. The beginnings of the lines are repeated here.

```
4046 FOR Z=1
;Z$: PRINT
4050 LET D$=
8-90----s---
4060 LET
4070 LET
```

I am glad to know that at least some of our readers actually use these programs even though they are a bit long to type in.

UNCLASSIFIED ADS

WANTED: UNCLASSIFIED ADS for publication in QZX. Cost is 1 cent for each keystroke (characters, blanks, etc.). Payment must be included with order. This is an excellent way to sell your program or unwanted equipment, ask for help, or find a specific program. Send your ad with payment to QZX, 2025 O'Donnell, Las Cruces, NM 88001.

QZX Discount: 15% discount on all orders mentioning QZX. T & C Services (address in ad in this issue).

WANTED: A Hunter Board. Fully populated if possible. Warren Tucker, 348 Idors Ave, Vallejo, CA 94591. Ph 1 (707) 643-5013. Or, by way of Packet BBS to WA6OUC@KJ6FY.#NORCAL.

WANTED: I need the owner's manual/schematic for Denton GLA 1000B amplifier. Will pay all costs. Hal Schweikart, 753 Yeadon Ave., Yeadon, PA 19050 (215)623 7435.

FOR SALE: Many items for sale, including TS1000 computers, printer, 16K & 64K RAMs, printer interface, word processor, books, commercial tapes, etc. Long SASE for list. Marty Irons, K2MI, 46 Magic Circle, Goshen, NY 10924.

FOR SALE: Book on CP/M operating system. CP/M User Guide 2nd Edition bu Thom Hogan. 286 pages. New. $4.95 + $1.05 shipping. Alex. F. Burr, 2025 O'Donnell, Las Cruces, NM 88001.

TS1000 AND TS2068 DIFFERENCES
K5XY

Both the TS1000 (including the ZX81 and TS1500) and the TS2068 share a similar dialect of BASIC. That means that the programs for one system are very much like the programs written for the other. Sometimes it is even hard to tell for which system a given program is designed. It is fortunate that this similarity exists; because very few new programs are being written for either system. Because the TS2068 was a later system, its language is larger. Also it has color, sound, and file handling capabilities the earlier models lacked. Still it is often possible to translate the basic functions of a program from one system to another. The following table of the main language differences between the two systems is presented as an identification and translation aid.

Differences Between the T/S 1000/1500 and the T/S 2068

New keys on T/S 2068:
Second Caps Shift Key
New Space Bar

T/S 1000/1500 Commands/Statements/Functions and Punctuation Not on T/S 2068:

" " (DOUBLE QUOTE)	[S] CURSOR ([?] CURSOR ON 2068)
UNPLOT	[F] CURSOR ([E] CURSOR ON 2068)
SCROLL	FUNCTION KEY
** (UP-ARROW ON 2068)	

T/S 2068 Commands/Statements/Functions and Punctuation Not on T/S 1000/1500:

CAPS LOCK	MOVE	[(LEFT BRACKET)
DEF FN	CAT	OUT
CLOSE #	MERGE	STICK
POINT	IN	SOUND
VERIFY	FREE	ATTR
] (RIGHT BRACKET)	ON ERR	PAPER
RESET	SCREEN $	OVER
\ (BACKSLASH)	INK	↑ (WAS ** ON 1000)
CIRCLE	BRIGHT	% (PERCENT)
BEEP	@ (AT SIGN)	READ
FLASH	! (EXCLAMATION)	BIN
INVERSE	CAPS SHIFT	{ (LEFT BRACE)
#	RESTORE	} (RIGHT BRACE)
& (AMPERSAND)	' (APOSTROPHE)	BORDER
DATA	[C] CURSOR	© (COPYRIGHT)
DRAW	INV. VIDEO	FN
[E] CURSOR (WAS F-CURSOR)	OPEN #	____ (UNDERLINE)
TRUE VIDEO	ERASE	[?] CURSOR (WAS S-CURSOR)
LINE	FORMAT	

INTRODUCTION TO SCL ARTICLE
K5XY

The following article is the first installment of a long description of the Sinclair Logic Chip (SCL), which is one of the most important IC's in the TS1000 series of computers (which includes the ZX81 and TS1500). This is a remarkable and educational article into which a lot of effort has gone. The SCL is a customized logic chip about which very little is known. Don Lamen had extensively studied its functions and had given us details of what he discovered. He even presents circuits that will perform the same operations; although, of course, they are not the actual circuits which are in our computers. Because no official information is available, Don admits that he may not always be right, but I know of no other technical information about this chip that is anywhere near as complete.

Don has spent too much time and written too much for it to appear in a single issue of QZX. Also a single subject issue runs the risk of leaving too many readers without something in which they are interested. Therefore the SCL information is being broken up into a series of articles. The exact number of installments depends on the number and length of other Sinclair articles I receive. You will want to keep them all together in a group because they will not be completely independent of each other. These articles are a slightly altered version of material which appeared in the SINCUS newsletter. There is so much good technical information here that I thought many of our readers would like to see it too.

EXPLORING THE TS1000 SINCLAIR LOGIC CHIP (SCL)
Don Lamen

Introduction

Early in 1982 I bought my first TS1000 computer. At the time, I was building my own computer based on the S-100 bus using the Z-80 microprocessor as the CPU. I bought the TS1000 intending to use it to write the ROM and character generator for the computer I was building.

When I plugger it in and tried it out, I discovered that the little TS1000 with a 16K RAM pack would do a lot more than the computer that I was building. The whole TS1000 system cost less than what I had spent building one 8K RAM board and the power that it used was next to nothing. Needless to say, my S-100 computer construction stopped the day I bought the TS1000.

Now I have seven computers amd four of them are Times or Sinclair computers. All of the Sinclair computers are excellent computers and with the proper peripherals they will measure up to anything on the market in the microcomputer field. These computers are also very portable, Since 1940, I have worked and played with computers, mainframes, minnies, and micros. We have come a long way since the old 6SN7 flip-flops.

Now for the problem part. It is my opinion that, in order to get maximum utility from any device, you need to know exactly who it works. Since the day I bought my first TS1000 to the present, I have read everything I could get my hands on trying to obtain an accurate understanding of the Sinclair Logic Chip. There are many viewpoints and different opinions about the functions of this chip.

On April 7, 1988 I decided to use the ROM routines to try and discover just what the SCL does and how it does it. The following is the result of that attempt. There may be some "errors or oversights or misconceptions. If anyone wishes to comment pro or con or had questions or something to add feel free to write me. If you desire a return letter, please include a SASE. My address is Donald B. Lamen, RT 3 - Box 3404, Windsor, NY 13865.

Results

While running the display routines on paper, keeping track of the timing in microprocessor T cycles, I discovered that each character row scan line takes 207 T cycles. Tis is the key to the entire timing chain.

Taking 207 T cycles as the length of each scan line (Including sync and retrace) and going through the entire display routine (including frame sync), I was able to resolve the length of the horizontal sync pulse. The horizontal sync pulse takes 19 microprocessor T cycles.

To understand the logic chip, we must remember that it is timed by the dot clock, which is twice as fast as the microprocessor clock. Therefore, one scan line is 414 dot cycles, the horizontal sync is 38 dot cycles, and so on.

The SCL chip

The SCL chip is a mask programable universal logic array (ULA 2C184E) made by Ferranti in Italy. This chip is programed at the time of manufacture by photo-masked deposition according to a table prepared by the equipment manufacturer (Sinclair). The SCL chip provides the following functions and/or circuits.

A Dot oscillator and internal clock
B Microprocessor clock
C Internal timing chain
D Horizontal sync generator
E Character scan line counter _ 3 bit
F Internal data bus
G Intercept control circuit
H Internal data latch
I NO-op generator
J Two shift-registers _ 8 bit, each
K Input I/O port FE _ 7 bit
L ROM driver buffer _ 9 bit
M I/O decoder
N NMI generator
O Frame (vertical) sync generator
P Video combiner and inverter circuit
Q ROM/RAM select circuit

The figures on the next two pages show the pin out designations of the ULA2C184E logic chip and diagram of the possible internal functional arrangement of the SCL.

The following installments of this article will discuss each of the functional modules in the above list.

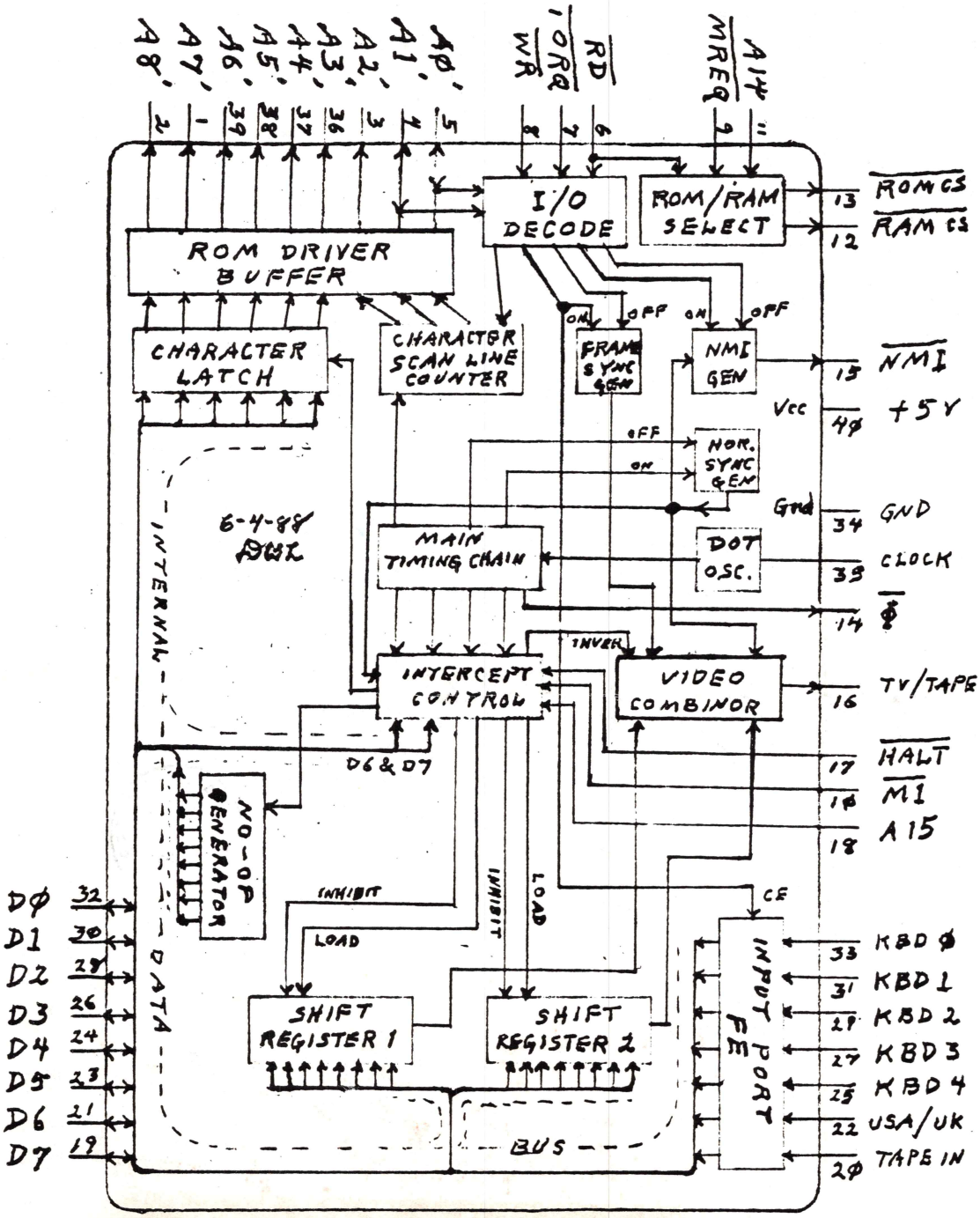
PIN DESIGNATIONS FOR THE ULA2C184E SCL CHIP

1	A7' →	40	+5V
2	A8' →	39	A6' →
3	A2' →	38	A5' →
4	A1' →	37	A4' →
5	AØ' →	36	A3' →
6	$\overline{RD}$ ←	35	CLOCK
7	IORQ ←	34	GND
8	$\overline{WR}$ ←	33	KBDØ ←
9	$\overline{MREQ}$ ←	32	DØ ↔
10	$\overline{M1}$ ←	31	KBD1 ←
11	A14 ←	30	D1 ↔
12	$\overline{RAM\ C.S.}$ →	29	KBD2 ←
13	$\overline{ROM\ C.S.}$ →	28	D2 ↔
14	CLOCK' →	27	KBD3 ←
15	$\overline{NMI}$ →	26	D3 ↔
16	TV/TAPE →	25	KBD4 ←
17	$\overline{HALT}$ ←	24	D4 ↔
18	A15 ←	23	D5 ↔
19	D7 ↔	22	USA/UK ← (Grounded for USA)
20	TAPE IN ←	21	D6 ↔

$f_{CLOCK} = 6.5$ MHz

$f_{CLOCK'} = 3.25$ MHz

FUNCTION DIAGRAM FOR THE ULA2C184E SCL CHIP



73, K5XY

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